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DEVELOPMENT OF DESIGN AND PRODUCTION PROCESSES FOR A BLOCK-ABLATOR HEATSHIELD WITH PRELIMINARY TEST RESULTS

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Abstract

The Ablatives Laboratory (ABL) was tasked by NASA to develop a producible block-ablator (B-A) design and to investigate manufacturing processes for a B-A heatshield system. The B-A concept is based on the milling of high-tolerance ablator blocks and the subsequent adhesive installation of these blocks into precision honeycomb already pre-bonded to an aeroshell structure. The concept originated with Peter T. Zell at NASA's Ames Research Center in 2007. During that time, the NASA thermal protection engineers were doing performance evaluation testing and developing heatshield designs made from PICA ablator for the Crew Exploration Vehicle (Orion) and other NASA systems. PICA, which was flown successfully on the Stardust mission, is a "ceramic" that has to be produced and applied monolithically for a small EDL vehicle or in large tiles, or "modules," for a larger vehicle. While PICA is reinforced internally with carbon fibers, PICA heatshield designs at that time did not have a secondary reinforcement system such as honeycomb. (Traditionally, ablative heatshield systems such as those used on Apollo, Viking, and MPF/MER used honeycomb reinforcement that was bonded to vehicle structure as a first step and then filled with polymeric ablator as a follow-on step. PICA as a "fired" and rigid ceramic is not packable into H/C by traditional methods.) The block-ablator concept was a potential design improvement for such a material. The idea was developed as a means of: 1) reinforcing and strengthening the lightweight and somewhat brittle PICA ceramic ablator; and 2) anchoring the heatshield via H/C bonding and enabling an initial pull-test of bonded, unfilled H/C to validate bond strength. The B-A concept is inclusive of a wide range of ablator materials, not just PICA and other lightweight ceramics. Molded, polymer-based ablators in a cured form might also be milled into precision blocks and bonded into block-ablator honeycomb. This paper discusses developed B-A production process, lessons learned from the fabrication of several manufacturing demonstration units, and some preliminary arc-jet test results on the performance of mid-density phenolic samples in the ABL block-ablator configuration.